INDOOR AIR QUALITY ASSESSMENT

Springfield State Office Building
436 Dwight Street
Springfield, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
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Background/Introduction

In response to a request from the Division of Capital Asset Management (DCAM) and Sam Topulos, building manager, the Bureau of Environmental Health Assessment (BEHA) conducted an indoor air quality evaluation at the Springfield State Office Building (SSOB), 436 Dwight Street, Springfield, Massachusetts on August 8, 2001. Michael Feeney, Chief of Emergency Response/Indoor Air Quality (ER/IAQ), BEHA, conducted this inspection. Concerns regarding microbial growth as a result of flooding in the basement on August 4, 2001 prompted the request. Preliminary recommendations and other information concerning water damage and microbial growth were previously outlined in a letter (MDPH, 2001), issued immediately following the inspection. This report will address general IAQ concerns.

The SSOB is a four-story, stone and cement building constructed in 1937 (see Picture 1) as a post office. The building was renovated in the 1970s and converted into a multi-agency state office building. Each floor contains various offices of Massachusetts government agencies, including the Governor's Office, the Attorney Generals Office, the Secretary of State's Office, MA Commission Against Discrimination as well as offices of the Departments of Environmental Protection, Revenue, Industrial Accidents, Mental Retardation and the Division of Capital Assets Management. Windows are not openable.

Methods

Air tests for carbon dioxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor, Model 8551. Moisture content of water-damaged materials was measured using a Delmhorst, BD-2000 Model, Moisture Detector.

Results

The building has an employee population of approximately 300 and an estimated 100-200 individuals visit the SSOB on a daily basis. Tests were taken under normal operating conditions and results appear in Tables 1-6.

Discussion

Ventilation

It can be seen from the tables that carbon dioxide levels were below 800 parts per million parts of air (ppm) in forty-eight out of fifty areas surveyed during the assessment, indicating adequate air exchange in the building. Please note that these measurements were taken on a day with an outdoor temperature measuring 96^{o} F in the shade. Ordinarily, the heating, ventilating and air-conditioning (HVAC) system would prevent the introduction of fresh air in extreme temperature conditions to conserve energy. These consistently low carbon dioxide readings indicate that SSOB maintenance staff are operating the HVAC system at an optimal capacity to provide fresh air in the building.

Fresh air is introduced by a number of rooftop-mounted air-handling units (AHU) and distributed through ducted, ceiling vents. Mechanical exhaust ventilation is provided by ceiling-mounted return diffusers/plastic grates. These grates were installed to allow heat to exhaust into the ceiling plenum.

Of note is the administrative and judge's lobby area of the Division of Industrial Accidents (DIA) office. This area was reconfigured from its original use, which appears to have been the loading dock/freight area for the former post office. A large, concrete/steel balcony exists along the exterior wall of this area (see Picture 2). The area beneath the balcony was subdivided and now serves as the DIA judge's chambers. Each of these offices has a fresh air diffuser at floor level (see Picture 3). The system provides fresh air for adequate temperature control in the DIA judge's chambers. No exhaust vents exist in the chambers. Grates in the suspended ceiling of the main administration area appear to be part of the ceiling plenum system. The ceiling plenum exhaust system is designed to draw air from an undercut below the judge's chamber door into the administrative area. Air then exits through the ceiling-mounted grates into the ceiling plenum. Corrugated decking partially obstructs the ceiling plenum grate (see Picture 4). This blockage can degrade the ability of the plenum system to remove normally occurring environmental pollutants, particularly from the judge's chambers when the hallway doors are closed.

To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of occupancy. In order to have proper ventilation with a mechanical supply and exhaust system, the systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. It is recommended that HVAC systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994).

The Massachusetts Building Code requires a minimum ventilation rate of 20 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week, based on a time weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches.

Temperature readings ranged from 71^{o} F to 78^{o} F, which were within the BEHA recommended range for comfort. The BEHA recommends that indoor air temperatures be maintained in a range of 70 ^{o} F to 78 ^{o} F in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

Relative humidity measurements ranged from 45 to 58 percent, which were within the BEHA recommended comfort range of 40 to 60 percent. Relative humidity levels in the building would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

As discussed previously, recommendations concerning remediation of flooding in the basement offices were outlined in a letter to Martha Goldsmith of the Massachusetts Division of Capital Assets Management (MDPH, 2001, Attachment A). The water damage to the courthouse was a result of a rainstorm that dropped several inches of rain within 20 minutes in the downtown Springfield area on August 4, 2001. The rainstorm resulted in the flooding of many buildings in the downtown Springfield area. Reportedly, the building had no history of previous flooding. Water damage was confined to the basement area, resulting in wetting of carpet and gypsum wallboard (MDPH, 2001).

The configuration of the building can make the lower level of the building vulnerable to flooding during flash flooding conditions. The building is surrounded by cement lined pits with drains (see Pictures 5 and 6). If the rate of water entering the cement-lined pit exceeds the drainage rate of the drains, the water level can rise and come into contact with window frames or the exterior door leading to the mechanical room. Of note is the design of the drainage system. According to staff, the roof drains for the building are connected to the sewer drain system, which has two pipes that exit the building through backflow preventers. The building flooded as a result of several factors/conditions. These events were not tied to failure of the drain backflow preventors and include:

- *The flooding of downtown Springfield*: Drains work by directing water from a building using gravity. If the sewer system for downtown Springfield were filled beyond capacity to the point of overflow, the water pressure created by flooding may prevent water from exiting the building. In essence, the flooding corked the drain system to prevent water flow from the building.
- *Roof drain connection to sewer lines:* In a downpour, rain that accumulates on the roof of the SSOB is directed to drains that are connected to sewer line connections. If water were prevented from exiting the building, the only place for it to go would be to accumulate within the drainage system.
- *Water seeks its own level:* If water were continually entering the system and could not exit the building through sewer lines, then water in the pipe system will accumulate and seek its own level. If holes exist in the drain system below the level of water in the system, water would be expected to exit from them (e.g., lower level drains).

Since the source of the flooding appears to be centered around a floor drain in the basement, the water that entered the basement would most likely be rainwater mixed with accumulated debris in floor drain traps, not sewage water from the Springfield system. Therefore, it is probably not the backflow preventers that failed, but more likely a result of a combined overloading of the SSOB and Springfield drainage systems that caused the flooding in the building.

Other potential contributions to excess moisture/mold concerns were also identified during the assessment. Plants located throughout the building, particularly on the 5th floor, can contribute to mold and/or spores. Plant soil, standing water and drip pans can serve as mediums for mold growth (see Pictures 7 and 8). Drip pans should be inspected periodically for mold growth. Over watering of plants should be avoided. Many plants are located on, above and around fan coil units. Dust, mold spores and pollen can be drawn into fan coils and distributed throughout a room.

Water coolers were located in several areas directly on carpeting. Porous materials that are repeatedly wet can serve as media for mold growth. The American Conference of Governmental Industrial Hygienists (ACGIH) recommends that porous materials be dried with fans and heating within 24 hours of becoming wet (ACGIH, 1989). If porous materials, such as wallboard and carpeting, were not dried within this time frame, mold growth may occur. Water-damaged carpeting cannot be adequately cleaned to remove mold growth.

Water damage to the ceiling system in several areas of the building was noted. Water-damaged ceiling tiles and other porous building materials can provide a source of microbial growth and should be repaired/replaced after a water leak is discovered.

Other Conditions

Several other conditions were noted during the assessment, which can affect indoor air quality. Of note were the amounts of materials stored in some areas. In both offices and cubicle areas, items were seen piled on windowsills, tabletops, counters, bookcases and desks. The large amount of items stored provides a means for dusts, dirt and other potential respiratory irritants to accumulate. These stored items (e.g., papers, folders, boxes) also make it difficult for custodial staff to clean. Dust can be irritating to the eyes, nose and respiratory tract.

Several rooms contained dry erase boards and dry erase board markers. Materials such as dry erase markers and dry erase board cleaners may contain volatile organic compounds (VOCs), such as methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve (Sanford, 1999) that can be irritating to the eyes, nose and throat.

A number of containers containing hazardous materials were discovered in a basement-level agency storeroom (see Pictures 9-11). Containers such as gasoline cans should be stored in a flameproof cabinet that meets the specifications of the National Fire Protection Association (NFPA) (NFPA, 1996).

Conclusions/Recommendations

In view of the findings at the time of the assessment, the following recommendations are made:

1. Complete corrective actions recommended in letter concerning flooding as soon as possible (see Appendix A).
2. Examine plants for mold growth in water catch basins. Disinfect water catch basins if necessary. Consider reducing the number of plants in certain areas. Remove plants from the proximity of fan coil units to prevent the aerosolization of mold, particulates and pollen.
3. Consider placing plastic/rubber mats beneath water coolers.

4. Repair roof/plumbing leaks and replace water-stained ceiling tiles and building materials. Examine the area above and around these areas for microbial growth. Disinfect areas of water leaks with an appropriate antimicrobial.
5. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize irritating effects of common indoor air contaminants that can be enhanced when the relative humidity is low. To control for dusts, a HEPA filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).
6. Relocate or consider reducing the amount of materials stored to allow for more thorough cleaning. Clean items regularly with a wet cloth or sponge to prevent excessive dust build-up.
7. Remove equipment in the basement and store it in an area with adequate mechanical exhaust ventilation to remove off gassing materials from the interior of the building. Flammable materials should be stored in a flameproof cabinet that meets the specifications of the NFPA (NFPA, 1996).
8. Examine the feasibility to increase the draw of air into the return vents of the ceiling plenum to increase removal of air from the DIA area.
9. Ventilation industrial standards recommend that mechanical ventilation systems be balanced every five years (SMACNA, 1994). Consult a ventilation engineer concerning re-balancing of the ventilation systems.

References

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NFPA. 1996. Flammable and Combustible Liquids Code. 1996 ed. National Fire Prevention Association, Quincy, MA. NFPA 30.

OSHA. 1997. Limits for Air Contaminants. Occupational Safety and Health Administration. Code of Federal Regulations. 29 C.F.R. 1910.1000 Table Z-1-A.

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SBBRS. 1997. Mechanical Ventilation. State Board of Building Regulations and Standards. Code of Massachusetts Regulations. 780 CMR 1209.0

SMACNA. 1994. HVAC Systems Commissioning Manual. 1st ed. Sheet Metal and Air Conditioning Contractors' National Association, Inc., Chantilly, VA.

Picture 1

Springfield State Office Building

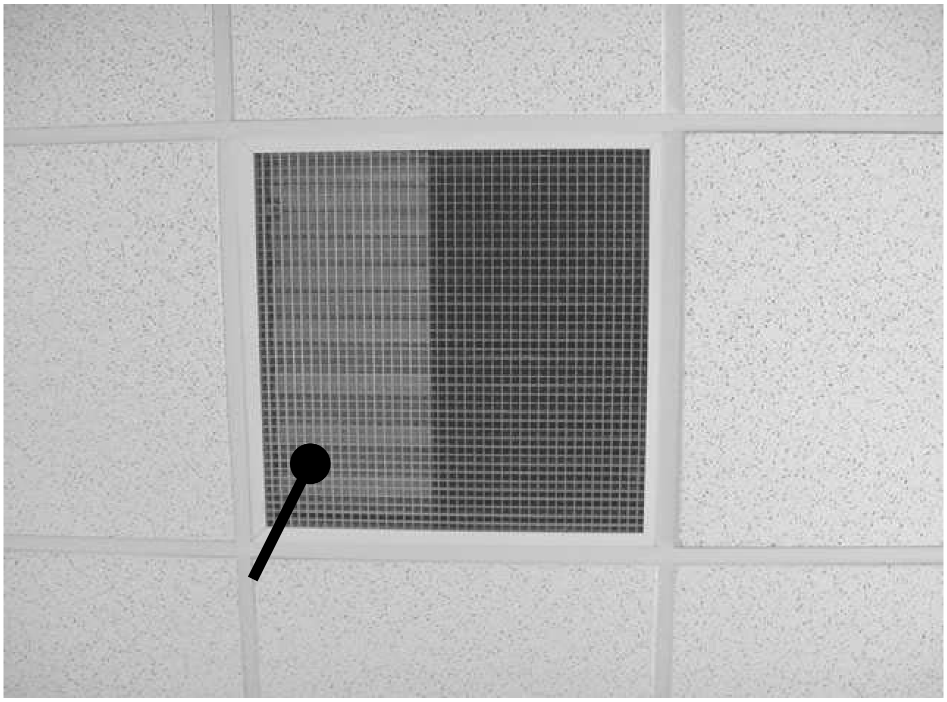
Picture 2

Large, Concrete/Steel Balcony Located Along the Exterior Wall of the DIA Office

Picture 3

Fresh Air Diffuser at Floor Level

Picture 4



Partially Obstructing the Ceiling Plenum Grate Is Corrugated Decking

Picture 5

Building Is Surrounded By Cement Lined Pits with Drains

Picture 6

Drain in Cement Lined Pit

Picture 7

Plant On Window Sill

Picture 8

Build Up Of Sludge in Drip Pan

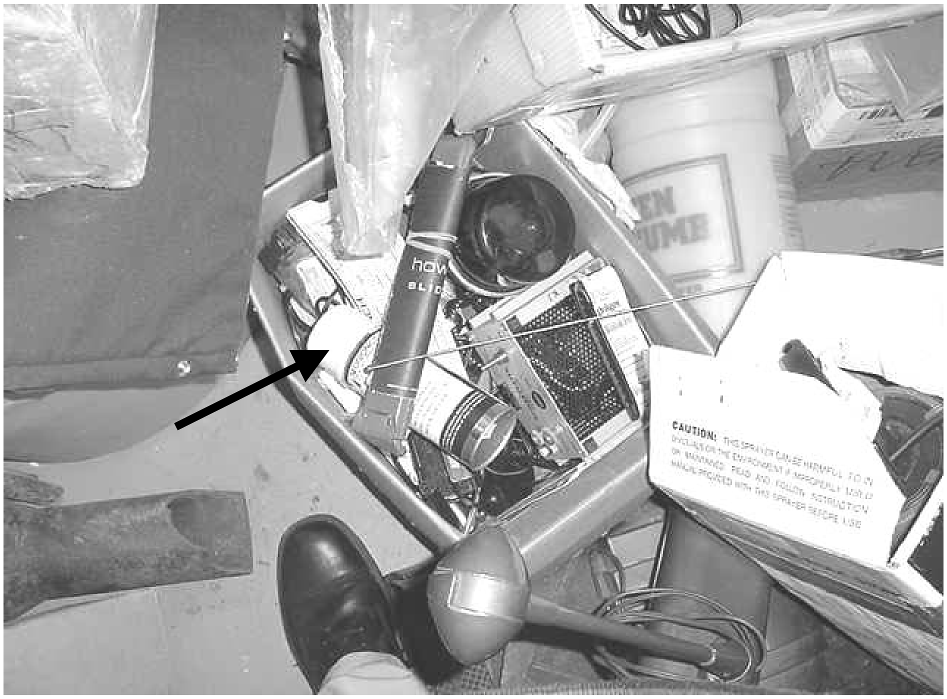
Picture 9

Spilled Materials in an Agency Storeroom in the Basement

Picture 10

Gasoline Containers in an Agency Storeroom in the Basement

Picture 11



Spray Can in an Agency Storeroom in the Basement

TABLE 1

Indoor Air Test Results – Springfield State Office Building
436 Dwight Street, Springfield, MA
August 8, 2001

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation Intake	Ventilation Exhaust	Remarks
Outside (Background)	367	96	45					
501	556	72	56	1	No	Yes	Yes	Plants, water cooler
503	586	72	57	1	No	Yes	Yes	Door open
504	584	71	57	0	No	Yes	Yes	Door open
DEP Printer Room	583	71	57	0	No	Yes	Yes	
500	601	71	58	1	No	Yes	Yes	
517	618	71	58	4	No	Yes	Yes	Door open
DEP Library	626	73	58	2	No	Yes	Yes	Water cooler, refrigerator
521	651	73	58	1	No	Yes	Yes	3 water damaged CT, photocopier
524	521	73	58	1	No	Yes	Yes	

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 2

Indoor Air Test Results – Springfield State Office Building
436 Dwight Street, Springfield, MA
August 8, 2001

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation Intake	Ventilation Exhaust	Remarks
527	602	72	57	1	No	Yes	Yes	1 water damaged CT, door open
304	607	75	53	2	No	Yes	Yes	1 water damaged CT
200 – Probation	555	74	55	3	No	Yes	Yes	
200 – Probation SW	584	75	55	0	No	Yes	Yes	Door open
200 – Meeting Room	898	75	57	5	No	Yes	Yes	Door open
202 – Commissioner of Deaf	573	75	54	1	No	Yes	Yes	1 missing CT, water cooler, open vent
210	498	75	55	1	No	Yes	Yes	1 water damaged CT
205 – DMR Front	492	75	54	3	No	Yes	Yes	
205 – DMR SE Corner	543	75	55	2	No	Yes	Yes	

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TABLE 3

Indoor Air Test Results – Springfield State Office Building
436 Dwight Street, Springfield, MA
August 8, 2001

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
205 – DMR SW Corner	478	74	54	2	No	Yes	Yes	Door open
205 – DMR NW Corner	481	75	54	2	No	Yes	Yes	4 water damaged CT
205 – DMR NE Corner	487	74	54	1	No	Yes	Yes	
202 – Front	471	75	54	2	No	Yes	Yes	Plant
202 – MCAD NE Office	491	75	54	3	No	Yes	Yes	Plants, door open
202 – MCAD Commissioner Reception	555	76	54	2	No	Yes	Yes	
109 – Foyer	505	76	56	1	No	Yes	Yes	
109 – Conference Room	486	75	56	1	No	Yes	Yes	Water cooler
109 – Desks, N Wall	599	76	58	1	No	Yes	Yes	

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Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 4

Indoor Air Test Results – Springfield State Office Building
436 Dwight Street, Springfield, MA
August 8, 2001

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation Intake	Ventilation Exhaust	Remarks
109 – NW Office	450	75	57	0	No	Yes	Yes	
109 – Interior Office	510	75	58	1	No	Yes	Yes	
109 – Interior Office	483	75	58	3	No	Yes	Yes	
105 – DOR	585	74	50	5	No	Yes	Yes	Water cooler, 3 water damaged CT
DIA – Industrial Accidents	642	74	53	2	No	Yes	Yes	
DIA – Hearing Room 1	634	74	54	0	No	Yes	Yes	Door open
DIA – Desk	729	75	55	5	No	Yes	Yes	
300 – Office of the Governor, Chief of Staff	572	73	55	1	No	Yes	Yes	Door open
300 – Main	639	74	54	2	No	Yes	Yes	

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Relative Humidity -	40 - 60%

TABLE 5

Indoor Air Test Results – Springfield State Office Building
436 Dwight Street, Springfield, MA
August 8, 2001

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation Intake	Ventilation Exhaust	Remarks
301 – DOR Office	565	73	52	2	No	Yes	Yes	Water cooler, 4’ floor dividers
308 – DOR Center Cubicles	647	74	53	4	No	Yes	Yes	
308 – DOR SE Cubicles	596	74	53	7	No	Yes	Yes	Water cooler
308 – DOR NE Cubicles	566	74	53	7	No	Yes	Yes	Water cooler, photocopier
308 – DOR N Cubicles	567	74	53	2	No	Yes	Yes	Plant-on newspaper, water cooler
308 – DOR NW Cubicles	512	74	52	1	No	Yes	Yes	Water cooler
313	546	73	53	5	No	Yes	Yes	Water cooler
3rd Floor Courthouse	535	76	52	0	No	Yes	Yes	Supply and exhaust off
311	587	75	51	1	No	Yes	Yes	
DIA – Judge Murphy’s	610	78	48	1	No	Yes	No	

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Relative Humidity -	40 - 60%

TABLE 6

Indoor Air Test Results – Springfield State Office Building
436 Dwight Street, Springfield, MA
August 8, 2001

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Chambers								
102 – Secretary of State	619	77	47	3	No	Yes	Yes	
104 – Division of B	634	76	46	3	No	Yes	Yes	Water cooler, dry erase board
120 – Snack Bar	557	77	45	2	No	Yes	Yes	Door open

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